

# CLAY AND SHALE

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The amount of clay sold or used by domestic producers in 2004 was 41.2 million metric tons (Mt) valued at \$1.68 billion (table 1). Common clay and shale accounted for 60% of the tonnage, and kaolin accounted for 56% of the value (tables 2, 7, 13). Imports of clays were 251,000 metric tons (t) valued at \$61.7 million. Exports were 5.63 Mt valued at \$936 million (table 1).

Major markets, in decreasing order by tonnage, for ball clay were floor and wall tile (35%), sanitaryware (26%), and pottery and miscellaneous ceramics (19%); for bentonite, foundry sand bond (24%), absorbents (23%), drilling mud (21%), and iron ore pelletizing (15%); for common clay and shale, brick (58%), portland cement (17%), and lightweight aggregate (15%); for fire clay, refractory products (54%); for fuller's earth, absorbents (78%); and for kaolin, paper coating and filling (66%).

## Production

In 2004, about 240 companies operated approximately 810 clay and shale pits or quarries. The 20 leading companies, many with multiple operations, accounted for 49% of the tonnage and 78% of the value for all types of clay produced and sold or used. Clay production was reported in all States except Alaska, Delaware, Hawaii, Idaho, New Hampshire, Rhode Island, Vermont, and Wisconsin (table 2). Companies not participating in the U.S. Geological Survey (USGS) canvass of the clay and shale industry probably extracted clay for construction uses in States for which no production was reported.

The 10 leading producer States, in decreasing order of tonnage, were Georgia, Wyoming, Alabama, Texas, North Carolina, Missouri, California, Ohio, South Carolina, and Mississippi. The 10 leading producer companies, in alphabetical order, were American Colloid Co. (bentonite); Big River Industries, Inc. (common clay and shale); Engelhard Corp. (bentonite, fuller's earth, and kaolin); General Shale Products Corp. (common clay and shale); Glen Gery Corp. (common clay and shale); Holnam, Inc. (common clay and shale); J.M. Huber Corp. (kaolin); Imerys (ball clay and kaolin); Oil-Dri Corp. (fuller's earth); and Thiele Kaolin Co. (kaolin).

Most clay mining in the United States was by open pit methods; less than 1% of U.S. clay output was from underground mines. All underground production was in Ohio where the clays are mainly underclays associated with coal.

Domestic production data for clays were developed by the USGS from a voluntary survey of U.S. operations. Responses to the survey and company data available from other sources accounted for approximately 60% of the total clay and shale sold or used quantity listed in table 1. The bulk of the nonrespondents were producers of common clay and shale. Production data for the nonrespondents were estimated from reported prior year production levels adjusted by trends in the industry and other guidelines.

**Ball Clay.**—In 2004, 4 companies mined ball clay from 47 pits in 4 States. Production of domestic ball clay was estimated to be 1.22 Mt valued at \$54.1 million (table 3). Production was less than in 2003 but still remained near record highs. Operations in Tennessee supplied 62% of the Nation's output, followed by, in descending order of tonnage, Texas, Mississippi, and Kentucky. One producer reported a small amount of production in Indiana, but this probably was fire clay rather than ball clay.

**Bentonite.**—In 2004, 24 companies produced bentonite from approximately 108 pits in 12 States. About 4.06 Mt valued at \$180 million of bentonite was sold or used (table 5). Production of nonswelling bentonite increased to 320,000 t valued at \$14.2 million in 2004. Two companies accounted for most of this increase. Mississippi led in the production of nonswelling bentonite, followed by, in descending order of tonnage, Alabama, Arizona, Nevada, Virginia, Colorado, and California.

Production of swelling bentonite increased to 3.74 Mt valued at \$165 million in 2004. The increase was distributed among several producers. Wyoming still led in the production of swelling bentonite, followed by Montana, Utah, Texas, California, Oregon, and Nevada.

Action Minerals Inc., entered into an agreement with Jefferson Minerals Corp. to develop a bentonite deposit in Wasco County, OR. The deposit contains about 9 Mt of reserves and resources consisting of several bentonite beds of different composition. Previously, less than 700 metric tons per year (t/yr) of bentonite was removed for sealant applications. Action Minerals initially planned to target the pet litter market (Action Minerals Inc., 2004).

**Common Clay and Shale.**—In 2004, 162 companies produced common clay and shale from approximately 459 pits in 41 States and Puerto Rico. In States not reporting production, common clay and shale probably was mined and sold for construction uses by companies not participating in the USGS canvass of the clay and shale industry.

Domestic sales or use of common clay and shale increased to 24.6 Mt valued at \$173 million (table 7). The major producing States, in descending order of tonnage, were North Carolina, Texas, Alabama, Georgia, Ohio, California, Arkansas, Oklahoma, and South Carolina.

Hanson Brick (a subsidiary of Hanson PLC) purchased Athens Brick Co. Inc. The acquisition included Athens Brick plants in Mooringsport, LA, and Athens and Mineral Wells, TX. The plants sell brick for commercial and residential construction and had a combined production of 90 million bricks per year. The purchase included more than 20 years of clay and shale reserves. Hanson Brick capacity now will be about 1.7 billion bricks per year (American Ceramic Society Bulletin, 2004).

Richland Moulded Brick Co., Mansfield, OH, sold a portion of its assets to ProServices USA, LLC. ProServices planned to operate its acquisition as Artisan Moulded Brick, LLC and continue to sell molded brick and paver products to commercial and residential customers in Eastern and Midwestern States and Canada (Chemical Industry CyberNews, 2004).

**Fire Clay.**—Fire clay producers were mostly refractory product manufacturers that used the clays in firebrick and other refractory products. In 2004, 6 firms in 3 States operated 22 pits. Fire clay sold or used by domestic producers decreased to 307,000 t valued at \$8.51 million (table 9). Production and sales declined for the past few years because refractory manufacturers have closed plants in response to reorganizations associated with asbestos litigation and bankruptcy proceedings. Missouri was the leading producing State, followed by, in descending order of tonnage, Ohio and South Carolina.

**Fuller's Earth.**—In 2003, 15 companies produced fuller's earth (attapulgitic and montmorillonite varieties) from 41 pits in 11 States. Production of fuller's earth declined to 3.26 Mt valued at \$329 million (table 11). The fuller's earth deposits grade from attapulgitic-rich in Florida to montmorillonite-rich further northward in Georgia. Only those clays with attapulgitic as the major clay component are classified as attapulgitic. These basically are the gellant-grade fuller's earths in Florida and the southernmost part of Georgia. Going northward into Georgia, the attapulgitic content of the fuller's earth declines, and montmorillonite becomes the dominant clay present. This is classified under montmorillonite although it contains minor to trace amounts of attapulgitic.

The attapulgitic variety of fuller's earth was mined from eight pits in the Florida Panhandle and southwestern Georgia. Only Engelhard and Zemex Corp. mined attapulgitic in the United States in 2004. An unspecified portion of the production was sold by ITC, Inc. under the terms of a U.S. Department of Justice agreement, making, in essence, three producers of attapulgitic. Attapulgitic production declined slightly to 237,000 t valued at \$30.1 million in 2004. Georgia led in the production of attapulgitic, followed by Florida.

Production of the montmorillonite variety of fuller's earth declined to 3.02 Mt valued at \$299 million in 2004. Several companies accounted for this decline, the larger of which were in Georgia, Illinois, Mississippi, and Virginia. Montmorillonite was produced, in decreasing order of tonnage, in Georgia, Missouri, Mississippi, Virginia, Illinois, California, Tennessee, Florida, Texas, and Kansas.

Sepiolite, although not a fuller's earth, was produced in Nevada. Sepiolite was included in the total for fuller's earth to avoid disclosing company proprietary data.

IMV Nevada (a subsidiary of Mud Camp Mining Co. LLC) was the only commercial producer of saponite and sepiolite in the United States. IMV mined a playa deposit in the Amargosa Desert near Ash Meadows, NV. The sepiolite was extracted from beds that average about 6 feet thick. Small amounts of calcite, dolomite, feldspar, illite, quartz, saponite, and volcanic glass also were present in the deposit. The sepiolite has a large surface area; it is highly absorptive so is used in animal feed, drill mud, fertilizer, joint compounds, oil absorption, and pet litter applications. About 24,000 t/yr is sold. Saponite also is mined from the deposit. Beds typically average about 5 feet in thickness. Saponite is a good cation exchanger, has gel and viscosity properties, and expands when wetted. These properties allow it to be used in slurry wall construction, stucco mixes, paper mill, and pet litter applications. About 6,000 t/yr is sold (Wahl and Papke, 2004).

**Kaolin.**—In 2004, 23 firms mined kaolin from approximately 115 pits in 10 States. Domestic production increased slightly to 7.76 Mt valued at \$936 million (table 13). The leading producer State was Georgia, followed by, in descending order of tonnage, Alabama, South Carolina, Arkansas, Texas, North Carolina, California, Nevada, Florida, and Tennessee.

Of the 7.76 Mt mined, 3.87 Mt was water washed, 1.40 Mt was calcined, 1.24 Mt was delaminated, 1.15 Mt was airfloat, and 101,000 t was unprocessed (table 14). Of the calcined kaolin, 853,000 t valued at \$250 million was pigment-grade (low-temperature calcined kaolin). Companies in Georgia accounted for nearly all the pigment-grade calcined kaolin produced in 2004. A small amount also was produced in Texas. The remainder was refractory-grade (high-temperature calcined kaolin) (table 15).

Kaolin production in Georgia was 6.78 Mt valued at \$889 million. Approximately 3.78 Mt of Georgia kaolin production was sold as water washed, 1.24 Mt was delaminated, 906,000 t was calcined (high- and low-temperature calcined kaolin), and 851,000 t was airfloat (table 16). Production in South Carolina was 296,000 t valued at \$19.6 million (table 18).

Para Pigmentos SA announced plans to construct a \$5 million kaolin mill in Searsport, ME. The company planned to import and reprocess kaolin from Brazil and distribute it to paper manufacturers in New England and Canada (Bangor Daily News, 2004<sup>1</sup>).

Atlas Mining Co. completed mine preparation and construction of associated facilities and began processing halloysite ore. Atlas Mining created a subsidiary, Nano Clay and Technology, Inc., to handle sales and marketing (Atlas Mining Co., 2004a, b).

Engelhard closed portions of its Gordon, GA, kaolin plant. The purpose of the closure was to become more competitive in the kaolin market. Some activities at the Gordon plant will be consolidated with those at the McIntyre, GA, plant (Engelhard Corp., 2004).

## Consumption

**Ball Clay.**—The principal domestic ball clay markets, in decreasing order, were floor and wall tile, sanitaryware, and miscellaneous ceramics (table 4). Sales and use, including exports, were 1.22 Mt, a decrease from that of 2003. Sales losses in refractory and export markets accounted for the bulk of the decrease.

**Bentonite.**—Domestic sales and use were estimated to be 3.64 Mt and total sales (domestic and export) were 4.06 Mt in 2004 (table 6). Major domestic markets for bentonite, in decreasing order by tonnage, were pet waste absorbent, drilling mud, foundry sand, and iron ore pelletizing. Total sales (domestic and exports) of bentonite were approximately 962,000 t for foundry sand bond (about 83% was swelling bentonite), 955,000 t for pet waste absorbent (more than 99% was swelling bentonite), 834,000 t for drilling mud (essentially all swelling bentonite), and 594,000 t for pelletizing iron ore (all swelling bentonite).

<sup>1</sup>References that include a section mark (§) are found in the Internet References Cited section.

Data for other bentonite markets were concealed to avoid disclosing company proprietary data. However, swelling bentonite accounted for more than 90% of the bentonite sold for absorbents, animal feed, civil engineering, drilling mud, miscellaneous chemical manufacture applications, paint, pelletizing iron ore, waterproofing, and water treatment and more than 70% of the bentonite sold for adhesives, foundry sand, and miscellaneous filler and extender applications. More than 50% of the bentonite sold for clarifying, decolorizing, and filtering of oils and greases was the nonswelling variety.

The major domestic markets for swelling bentonite, in decreasing order, were pet waste absorbents, drilling mud, foundry sand, iron ore pelletizing, and sealing and waterproofing. Major export markets for swelling bentonite, in decreasing order, were foundry sand, iron ore pelletizing, and drilling mud applications. The major domestic uses for nonswelling bentonite, in descending order of tonnage, were foundry sand bond; clarifying, decolorizing, and filtering of oils and greases; absorbents; drilling mud; and animal feed.

Sodium bentonite mined in the Western United States (Wyoming bentonite) continued to be competitive in foreign markets despite the strength of the U.S. dollar and attempts to increase the use of locally sourced bentonite mined where energy, labor, and transportation may have been less expensive. The greatest competition for Wyoming bentonite producers in foreign markets was sodium-activated bentonite. Wyoming and sodium-activated bentonite competed primarily in civil engineering, drilling mud, foundry, and geosynthetic clay liner applications. About 11.7 Mt of bentonite was produced worldwide in 2003. About 35% of production was believed to be natural sodium bentonite, 15% to 25% calcium bentonite, and 40% to 50% sodium-activated bentonite. The purity and consistency of the Wyoming bentonite, the reliable supply network, performance characteristics, and efficiency of scale have allowed U.S. producers to be competitive worldwide. When comparing Wyoming bentonite to sodium-activated bentonite, the added expense of activation and additional processing and, in some cases, product reformulation, made the use of Wyoming bentonite more cost effective (Landis and Gray, 2004).

The European Commission issued a proposal that could elevate the importance of distinguishing between natural and sodium-activated bentonite. The objective of the proposal was to protect the environment and the public from potentially hazardous materials. Wyoming bentonite would be exempt from health testing under the proposal because it is naturally occurring and not chemically modified during manufacturing. The question arose as to whether or not sodium-activated bentonite would be exempt because it is chemically modified during processing. A major problem is that with similar colloidal and chemical properties for natural and sodium-activated bentonite, many users cannot distinguish between the two types. A method that measures isotope ratios for carbon and oxygen has been tested. The method appeared to be able not only to distinguish between natural and sodium-activated bentonite but also between sodium-activated bentonite from Greece and India, which are major producers of sodium-activated bentonite. The isotope geochemistry may better define natural sodium bentonite and also enable users to better evaluate the performance of bentonite from various sources (Landis and von Maubeuge, 2004).

**Common Clay and Shale.**—Common clay and shale was used most frequently in the manufacture of heavy clay products (such as building brick, drain tile, flue linings, and terra cotta), lightweight aggregate, portland cement, sewer pipe, and structural tile (table 8). Consumption of common clay and shale increased slightly to 24.6 Mt in 2004. Brick manufacture remained the leading market for common clay and shale, followed by, in descending order of tonnage, portland cement and lightweight aggregate. Residential and nonresidential construction, on which the common clay and shale industry is dependent, increased in value to \$1.03 trillion in 2004 from \$925 billion in 2003 (U.S. Census Bureau, 2005\$).

**Fire Clay.**—Fire clays were used in grogs and calcines; high-alumina brick and specialties; ramming and gunning mixes; refractory products, such as firebrick and block; mortars and mixes; and saggers. Fire clays also were used to produce such items as brick and pottery.

Consumption of fire clay decreased to 307,000 t in 2004 as a result of cutbacks in production capacity by refractory manufacturers (table 10). Markets for fire clay, in descending order of tonnage, were refractory mortar and cement, portland cement, common brick, and miscellaneous refractory products.

**Fuller's Earth.**—The major domestic uses for attapulgite and montmorillonite varieties of fuller's earth, in descending order of tonnage, were pet waste absorbents; oil and grease absorbents; portland cement manufacture; drilling mud; clarifying, decolorizing, and filtering of oils and greases; miscellaneous absorbents; pesticide carrier; fertilizer carrier; and miscellaneous fillers and extenders (table 12). Consumption of fuller's earth was 3.26 Mt in 2004.

Major domestic markets for montmorillonite, in descending order of tonnage, were pet waste absorbents; oil and grease absorbents; portland cement; clarifying, decolorizing, and filtering of oils and greases; pesticide carrier; asphalt tile, miscellaneous absorbents; drilling mud; miscellaneous refractory products; and fertilizer carrier. Although reported to be 2.4 Mt in 2003, sales for pet waste absorbent probably were nearer to 2.0 Mt based on current markets, making a slight increase in this category for 2004. The leading export market was pet waste absorbent.

Sales of attapulgite reported by producers were 237,000 t in 2004 (table 11). Most of the sales data were concealed to avoid disclosing company proprietary data. Major markets for attapulgite, in decreasing order, were drilling mud; fertilizer carrier; miscellaneous filler and extender applications; absorbents; animal feed; miscellaneous refractory products; clarifying, decolorizing, and filtering of mineral oils and greases; paint; asphalt tile; gypsum products; cosmetic, medical, pharmaceutical applications; and adhesives.

Sales of the montmorillonite variety of fuller's earth accounted for more than 80% of sales of fuller's earth for asphalt tile; portland cement manufacture; clarifying, decolorizing, and filtering of oils and greases; oil and grease absorbents; pesticide carriers; pet waste absorbents; and exported products. Attapulgite accounted for most of the sales for adhesives; animal feed; cosmetic, medical, and pharmaceutical applications; drilling mud; gypsum products; paint; textiles; miscellaneous filler and extender applications; and miscellaneous refractory products.

**Kaolin.**—Consumption of kaolin increased to 7.76 Mt in 2004 (table 14). The major domestic markets for kaolin, in descending order of tonnage, were paper coating and filler, refractory products, fiberglass, paint, rubber, and catalyst (table 20). Major domestic

markets for kaolin from Georgia, in descending order by tonnage, were paper coating, paper filling, fiberglass, paint, refractory products, and catalyst manufacture (table 17). Major domestic markets for kaolin from South Carolina, in descending order of tonnage, were rubber, catalyst, fiberglass, brick, adhesives, and roofing granules (table 19). The major export market for kaolin from South Carolina was rubber applications.

**Uses.**—By application, consumption of clays was as follows:

**Absorbent Uses.**—Sales reported by producers for absorbent uses were about 3.60 Mt. Fuller's earth accounted for about 73% of the clay used for absorbents, followed by bentonite and a small amount of kaolin. Pet waste absorbents accounted for 90% of absorbent consumption, followed by oil and grease absorbents and miscellaneous absorbent applications.

**Ceramics.**—All varieties of clays were used in ceramics. Demand for clay in the manufacture of ceramics, ranging from china to sanitaryware to roofing granules, was 2.36 Mt. The leading ceramics market was ceramic floor and wall tile (39%), followed by sanitaryware (18%), pottery (12%), roofing granules (11%), catalyst (8%), miscellaneous ceramics (6%); fine china (3%), electrical porcelain (2%), and quarry tile (1%). Ball clay accounted for 44% of the clay used in ceramics, followed by common clay and shale (34%) and kaolin (22%). Small amounts of bentonite also were used in the manufacture of ceramics. Ball clay dominated the crockery, electrical porcelain, glazing, and sanitaryware markets. Common clay and shale was the predominant clay used in pottery, quarry tile, and roofing granules. Kaolin dominated the catalyst market. Ball clay and common clay and shale were the predominant clays used in floor and wall tile manufacture, and ball clay and kaolin dominated the fine china market.

In 2004, apparent consumption of clay floor and wall tile in the United States was 292 million square meters valued at \$2.86 billion. Domestic producers shipped 64.3 million square meters of clay floor and wall tile valued at \$877 million in 2004 compared with 57.1 million square meters valued at \$758 million in 2003. Exports were 3.24 million square meters valued at \$26.9 million. Imports of clay floor and wall tile were 231 million square meters valued at \$2.01 billion (U.S. Census Bureau, 2005a).

The U.S. Department of Commerce, International Trade Administration (2004§) reported that approximately 29.2 million square meters valued at \$198 million of glazed and unglazed ceramic tile with sides measuring less than 7 centimeters was imported compared with 26.8 million square meters valued at \$180 million in 2003. Brazil, Italy, and Spain were the major sources of imported tile.

Imports of ceramic baths, bidets, flush tanks, lavatories, sinks, toilet bowls, and other ceramic sanitary fixtures increased in 2004. The U.S. Department of Commerce, International Trade Administration (2004§) reported imports to be 31.2 million units compared with 24.9 million units in 2003. China and Mexico were the major sources of imported sanitaryware.

**Construction.**—Common clays and shales were used to manufacture a wide variety of construction materials, including expanded aggregates, hydraulic cement, and structural clay products.

**Expanded Clay and Shale.**—Approximately 3.76 Mt of clay and shale was used in the production of lightweight aggregates (table 21). All the clay used to manufacture lightweight aggregates was common clay and shale. Lightweight aggregates were used in concrete block, structural concrete, and highway surfacing, in decreasing order of consumption.

**Hydraulic Cement.**—Clays provide the alumina and silica required to manufacture hydraulic cements. In 2004, approximately 4.56 Mt of clays was consumed in the production of cement. In descending order of tonnage, common clay and shale, fuller's earth, fire clay, and kaolin were used in the manufacture of portland cement clinker. About 92% of the clay consumed by the cement industry was common clay and shale.

**Structural Clay Products.**—Approximately 14.7 Mt of clays was used in the manufacture of structural clay products, such as building brick, roofing tile, and sewer pipe. Common and face brick accounted for about 98% of this total. Other markets, in descending order of tonnage, were miscellaneous clay products, flue linings, flower pots, roofing tile, sewer pipe, structural tile, and drain tile. About 99% of the clay used to manufacture structural clay products was common clay and shale. Small amounts of ball clay, bentonite, fire clay, and kaolin also were used.

In 2004, domestic producers shipped 9.39 billion building and face bricks compared with 8.52 billion bricks in 2003. About 148,000 t of vitrified clay sewer pipe and fittings valued at \$61.8 million was shipped in 2004 compared with 132,000 t in 2003 (U.S. Census Bureau, 2005a).

**Drilling Mud.**—Sales of clays for drilling mud applications were 883,000 t (domestic) and 58,200 t (exported). Swelling-type bentonite accounted for 89% of the clay used in drilling mud. Fuller's earth also was used in drilling mud applications. Sales of drilling muds increased slightly in 2004 as the result of increased oil drilling activity. The average number of rotary rigs in Canada and the United States operating in 2004 was 1,300 per month compared with 958 per month in 2003 (Baker Hughes Inc., 2005§).

**Fillers, Extenders, and Binders.**—Clays are used as fillers, extenders, and binders in a wide variety of products, such as adhesives, flooring products, paint, paper, and rubber. About 4.23 Mt of clays was sold for use as fillers, extenders, and binders in the United States. An additional 2.18 Mt of clays was exported for filler and extender applications. Paper coating and filling accounted for 69% of domestic sales, followed by miscellaneous filler and extenders (9%), paint (8%), rubber (4%), and plastics (2%). Adhesives; animal feed; asphalt emulsion; cosmetic, medical, pharmaceutical; fertilizer carrier; gypsum products; pesticide carrier; textile; and wallboard applications each accounted for less than 2% of the fillers and extenders markets.

Kaolin accounted for approximately 91% of the clay used in domestic filler and extender applications, followed by common clay and shale (3%), fuller's earth (3%), bentonite (2%), and ball clay (1%). Bentonite was the predominant clay used for animal feed and cosmetic, medical, and pharmaceutical applications; fuller's earth dominated in fertilizer and pesticide applications. Kaolin was the predominant clay used for adhesives, gypsum products, paint, paper, plastics, and rubber markets.

The paper industry used 30 Mt of minerals worldwide in 2003 with about 90% or 27 Mt being used in printing and writing paper. Within the printing and writing paper sector, 38% was used for coated wood-free paper; 31%, for uncoated wood-free paper; 21%, to produce coated mechanical papers; and 10%, for uncoated mechanical paper. In producing these papers, about 60% of the minerals were used as coatings and 40% as fillers. Ground calcium carbonate accounted for 38.7% of the minerals used in printing and writing

papers, followed by kaolin with 37.6%, precipitated calcium carbonate with 16.6%, and others with 7.1%. Kaolin is the dominant filler mineral with 45% of the market, followed by precipitated calcium carbonate with 26% and ground calcium carbonate with 18%. Ground calcium carbonate is the dominant coating mineral with 53% of the market, followed by kaolin with 45% and precipitated calcium carbonate. Mineral usage is expected to increase at a rate of 2.5% per year with growth in the coating market approaching 3% to 4% per year. Markets in Japan, North America, and Western Europe will continue to be slow with the greatest market growth in Southeast Asia (Harris, 2004).

The U.S. Census Bureau (2005b) reported shipments of paint and coatings for 2004 to be 1.56 billion gallons (5.90 billion liters). Of this amount, architectural paints, the major market for paint-grade fillers, was 809 million gallons (3.06 billion liters) compared with 762 million gallons (2.88 billion liters) in 2003.

**Fiberglass.**—Sales, including exports, to the fiberglass and mineral wool industry were 491,000 t. Nearly all the clay used for fiberglass was kaolin. While industry statistics are not available on fiberglass production, industrial sand (ground and unground) used for the production of fiberglass was 1.74 Mt in 2004 compared with 1.51 Mt in 2003 (T.P. Dolley, physical scientist, U.S. Geological Survey, written commun., August 7, 2005).

**Iron Ore Pelletizing.**—Sales of clays for iron ore pelletizing applications reported by producers were 594,000 t (526,000 t used domestically and 68,100 t exported). Swelling bentonite was the only type of clay used for this application.

Kobe Steel Ltd. and Midrex Technologies Inc. operated a pilot plant in Minnesota using the Itmk3<sup>®</sup> technology developed by Kobe. The Itmk3<sup>®</sup> process mixed iron ore fines with pulverized coal. The mixture was formed into pellets that were heated in a rotary hearth furnace. The furnace, operating at 1,300° C to 1,450° C, reduced the ore pellets and produced nuggets containing 96% to 98% iron and 2% to 4% carbon. The nuggets were roughly equivalent to those obtained from a blast furnace. The benefit was that the process did not require a blast furnace, sinter plants, or coke ovens. Additionally, the process was more energy efficient and released 20% fewer carbon dioxide emissions than blast furnace operations. Of greater significance was that the process did not require bentonite for pelletizing the ore. The technology was still in the experimental phase and has not yet had an impact on bentonite sales for pelletizing iron ore (Burke, 2004).

**Paper Products.**—Kaolin accounted for almost all the clay sales used for paper coating (2.47 Mt sold domestically and 1.92 Mt exported) and essentially all the clay used for paper filling (465,000 t sold domestically and 129,000 t exported).

**Refractory Products.**—Producers reported that 1.70 Mt of clays was used for the domestic manufacture of refractory products in 2004 (2.45 Mt with foundry sand included). Foundry sand accounted for 30% of domestic sales and all export sales under the refractory category. Other refractory markets for clays were firebrick; grogs and calcines; high-alumina brick and kiln furniture; plug, tap, and wad products; and refractory mortar and cement. About 217,000 t was exported for refractory applications.

Bentonite accounted for 962,000 t of refractory sales (745,000 t domestic and 217,000 t exported), followed by common clay and shale (749,000 t), kaolin (732,000 t), fire clay (165,000 t), and ball clay and fuller's earth combined (56,000 t).

The U.S. Census Bureau (2005c) reported the value of shipments of clay refractory products to be \$819 million in 2004 compared with \$828 million in 2003.

## Prices

Major clay producers announced price increases for ball clay and kaolin products. Increased energy cost, affecting production and transportation costs, was the main reason for the increases. Several of the unit values given below for specific clay types are slightly lower than in 2003. It appears that some producers underreported their sales values in 2004 and that some unit values should be increased by 3% to 7% to account for the energy surcharges instituted in 2004.

**Ball Clay.**—The average value for ball clay reported by domestic producers was \$44.24 per metric ton. The average values for exported and imported ball clay were \$77 per ton and \$419 per ton, respectively.

**Bentonite.**—The average value reported by domestic producers for nonswelling bentonite was \$44.23 per ton. The average value for swelling bentonite was \$44.21 per ton. The average value for all bentonite was \$44.23 per ton. The average value of imported bentonite was \$359 per ton. The average value of exported bentonite was \$114 per ton.

The price, ex-works, Wyoming, crude, bulk, railcars, was \$26 to \$63 per ton; foundry-grade, bagged, railcars, \$50 to \$76 per ton; and American Petroleum Institute (API)-grade, bagged, railcars, \$43 to \$53 per ton. The price for bentonite, India, crushed, dried, loose in bulk, was \$30 to \$40 per ton for API-grade; \$32 to \$40 per ton for pet litter grade; and \$40 to \$45 per ton for foundry grade (Industrial Minerals, 2004b).

**Common Clay and Shale.**—The average value for all common clay and shale produced in the United States and Puerto Rico was \$7.05 per ton. The average value of clay and shale used in lightweight aggregate was \$20.54 per ton. The value for lightweight aggregate is an estimate of the clay value. Average prices for lightweight aggregate produced from clay and shale ranged from \$30 to \$50 per ton for most applications.

**Fire Clay.**—The average value for fire clay reported by domestic producers was \$27.72 per ton. The average of imported fire clay was \$284 per ton. The average value of exported fire clay was \$97 per ton.

**Fuller's Earth.**—The average value of attapulgite-type fuller's earth was \$126.96 per ton. The average value of montmorillonite-type fuller's earth was \$98.76 per ton. The average value of all fuller's earth was estimated to be \$100.84 per ton. The average value of imported fuller's earth was \$211 per ton. The average value of exported fuller's earth was \$210 per ton.

**Kaolin.**—The average value of kaolin was \$120.64 per ton for all kaolin grades. The average value for airfloat was \$54.49 per ton; refractory-grade (high-temperature calcined), \$30.12 per ton; pigment-grade (low-temperature calcined), \$293.24 per ton; all types of calcined, \$190.57 per ton; delaminated, \$126.19 per ton; water washed, \$115.86 per ton; and unprocessed, \$18.35 per ton. The average value of the imported kaolin was \$188 per ton. The average value of exported kaolin was \$165 per ton.

The price, ex-works, Georgia, filler, bulk, was \$80 to \$100 per ton; coating, bulk, \$85 to \$185 per ton; sanitaryware-grade, bagged, \$65 to \$75 per ton; tableware-grade, bagged, \$125 per ton; and calcined, bulk, \$320 to \$375 per ton (Industrial Minerals, 2004b). Prices were \$100 to \$250 per ton for hydrous pigment-grade kaolin and \$320 to \$375 per ton for calcined pigment-grade kaolin (Ryan, 2004).

## Foreign Trade

**Ball Clay.**—Ball clay exports decreased to 107,000 t valued at \$8.2 million, according to the U.S. Census Bureau (table 23). Imports were 520 t of ball clay valued at \$218,000 (table 24).

**Bentonite.**—Bentonite exports increased to 915,000 t valued at \$105 million (table 23). Exports to Canada and Japan increased by 74,000 t and 49,000 t, respectively. The remainder of the 194,000 t increase from 2003 to 2004 was distributed among eight other countries. Domestic bentonite producers reported exports of 424,000 t (table 6). The large discrepancy between data reported by producers and the U.S. Census Bureau resulted from producers including most of the exports destined for Canadian and Mexican markets (317,000 t) under domestic sales. In addition, some bentonite is packaged domestically and then exported as a finished product, such as cat litter. Sales through U.S. mineral brokers, where producers do not know if the bentonite is used domestically or exported, could also explain part of the discrepancy.

Bentonite imports consisted mainly of untreated bentonite clay and chemically or artificially activated materials. Imports of untreated bentonite were 9,340 t valued at \$3.36 million. Imports of chemically activated material were 24,900 t valued at \$14.2 million (table 24).

**Fire Clay.**—Approximately 332,000 t of fire clay valued at \$32.3 million was exported (table 23). Imports amounted to 5,920 t valued at \$1.68 million (table 24).

**Fuller's Earth.**—Approximately 49,000 t of fuller's earth valued at \$10.3 million was exported (table 23). Approximately 227 t of decolorizing earth and fuller's earth valued at \$48,000 was imported (table 24).

**Kaolin.**—The U.S. Census Bureau reported that 3.64 Mt valued at \$600 million was exported (table 23). Producers reported exports of 2.29 Mt (table 20). Of the 1.35 Mt difference, probably much of the 790,000 t destined for Canada and 206,000 t for Mexico was reported under domestic consumption. Sales through U.S. mineral brokers, where producers do not know if the kaolin is used domestically or exported, could also explain part of the discrepancy.

Kaolin imports decreased to 205,000 t valued at \$38.6 million (table 24). Most of the kaolin was imported from Brazil followed by the United Kingdom. Imports from Brazil were primarily for paper coating applications, and those from the United Kingdom were primarily for paper filler applications.

## World Review

World production of bentonite was approximately 10.5 Mt, fuller's earth production was estimated to be 5.06 Mt, and kaolin production was 44.4 Mt (tables 25-27). The world production data for kaolin also contain common clay from Colombia, ball clay from Australia, and crude kaolin ore production tonnages from many other countries. Sales of processed kaolin were estimated to be about 24.6 Mt, after excluding 8.4 Mt of common clay from the total for Colombia and 3.4 Mt for the Czech Republic, 4 Mt for Uzbekistan, 3.1 Mt for Germany, 600,000 t for Iran, 200,000 t for Egypt, and 100,000 t for Australia to account for processing losses. The United States continued to be the leading supplier of processed clay for sale, followed by Greece, Turkey, and the Commonwealth of Independent States for bentonite; Spain and Germany for fuller's earth; and the United Kingdom and Brazil for kaolin. Spain led all countries in the production of sepiolite.

There is a variety of specialty clays produced worldwide, including attapulgite, halloysite, hectorite, and sepiolite. The United States was the leading producer of attapulgite with production of 218,000 t in 2002 followed by Senegal with production of about 180,000 t/yr. Other producers of attapulgite were Australia, China, Greece, South Africa, and Spain. Total world production was estimated to be 564,000 t. Attapulgite was used primarily for adsorbent applications. Other uses were as gelling and rheological control agents in a wide variety of products and processing of oils and greases. Production of pure halloysite was estimated to be about 5,000 t/yr worldwide with China and Turkey producing about 2,500 t/yr each. The major market for halloysite from these countries was ceramics. A halloysite deposit was being developed in the United States in Utah. China, New Zealand, and Thailand were the major producers of mixed halloysite and kaolin ores. World production was estimated to be 150,000 t/yr. Major markets were in ceramics. The United States accounted for almost all world hectorite production with 50,000 t/yr. Hectorite was used primarily as a rheological agent. About 600,000 t/yr of sepiolite was produced in Spain with small tonnages produced in South Africa. More than 70% of the sepiolite was used in pet litter applications (Wilson, 2004).

**Europe.**—The trade associations for the European kaolin producers and the European producers of clays for fine ceramics and refractory products merged in 2004 to form the European Kaolin and Plastic Clays Association. The objective of the merger was to better represent European clay producers in the face of increasing European legislation that affects mining (Industrial Minerals, 2004a).

**Brazil.**—Companhia Vale do Rio Doce (CVRD) sold its share in Para Pigmentos SA (PPSA) to Caemi Mineralção e Metalurgia SA (a subsidiary of CVRD). Caemi produced kaolin through its subsidiary CADAM S.A. PPSA produced about 200,000 t of kaolin in the first 6 months of 2004 and has a capacity of 600,000 t/yr (Companhia Vale do Rio Doce, 2004).

**Greece.**—Geohellas SA commissioned the construction of a mining and processing operation in the western part of Macedonia Prefecture. The plant will have a capacity of 100,000 t/yr and will process attapulgite and saponite from their deposits at Grevena.

The company will market the clays for cat litter; clarifying, decolorizing, and refining media; oil and grease absorbents, and rheological applications (O'Driscoll, 2004).

## Outlook

The growth of the U.S. economy slowed in 2005 but still remained above the levels of 2002 and 2003. Construction-oriented markets for clay-based products, such as brick, cement, ceramic tile, lightweight aggregate, and whiteware, remain strong. It is likely that sales of ball clay and common clay probably will increase over the next few years to meet the anticipated demand for these materials. Sales of fire clay probably will decline during the next 3 to 4 years as refractory markets continue to be eroded by the effects of asbestos litigation. The total market for fuller's earth is not expected to change significantly in the next 2 years. Consequently, sales of fuller's earth probably will remain at or slightly above 2004 levels in the near future.

Rotary drilling for oil exploration and extraction worldwide continued above levels of previous years (Baker Hughes Inc., 2005\$). This should result in the continued increase in the demand for bentonite for drilling mud applications. Sales for pet litter markets have slowly increased during the past 5 years with slight growth anticipated in that market. Foundry sand and pelletizing markets have been flat with no expected increases in the near future. Other markets for bentonite have been unchanged for the past few years and are likely to remain so for the short term.

Shipments of paper have slowed in 2005. Kaolin imports from Brazil may limit growth in sales from U.S. kaolin producers to the North American paper market. However, kaolin sales globally are expected to increase with filler grades from Brazil and coating grades from Georgia absorbing a large share of the increase (Van Savage, 2004). Sales in other kaolin markets have been generally flat in the past 5 years with minor fluctuations from year to year. Sales probably are going to remain unchanged in the near future after several years of decline resulting from losses of sales to the paper industry.

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TABLE 1  
SALIENT U.S. CLAY STATISTICS<sup>1, 2</sup>

(Thousand metric tons and thousand dollars)

	2000	2001	2002	2003	2004
Domestic clays sold or used by producers:					
Quantity	40,800	39,600	39,300	40,000	41,200
Value	1,520,000	1,510,000	1,580,000	1,660,000	1,680,000
Exports:					
Quantity	5,260	4,970	4,960	5,130	5,630
Value	896,000	836,000	817,000	859,000	936,000
Imports for consumption:					
Quantity	96	148	217	279	251
Value	34,900	33,900	39,400	51,200	61,700

<sup>1</sup>Excludes Puerto Rico.

<sup>2</sup>Data are rounded to no more than three significant digits.

TABLE 2

CLAYS SOLD OR USED BY PRODUCERS IN THE UNITED STATES IN 2004, BY STATE<sup>1,2</sup>

(Thousand metric tons and thousand dollars)

State	Ball clay	Bentonite	Common clay and shale	Fire clay	Fuller's earth	Kaolin	Total	
							Quantity	Value
Alabama	--	100	2,120	--	--	W	2,220	32,700
Arizona	--	W	W	--	--	--	W	W
Arkansas	--	--	1,150	--	--	W	1,150	1,510
California	--	24	1,230	--	W	W	1,260	23,300
Colorado	--	W	249	--	--	--	249	1,510
Connecticut	--	--	87	--	--	--	87	W
Florida	--	--	W	--	W	31	31	3,280
Georgia	--	--	1,550	--	1,400	6,780	9,720	1,040,000
Illinois	--	--	247	--	218	--	465	1,390
Indiana	W	--	729	--	--	--	729	8,910
Iowa	--	--	325	--	--	--	325	1,150
Kansas	--	--	621	--	W	--	621	7,460
Kentucky	W	--	978	--	--	--	978	4,510
Louisiana	--	--	399	--	--	--	399	11,000
Maine	--	--	49	--	--	--	49	W
Maryland	--	--	262	--	--	--	262	571
Massachusetts	--	--	36	--	--	--	36	W
Michigan	--	--	605	--	--	--	605	3,070
Minnesota	--	--	20	--	--	--	20	22
Mississippi	W	W	610	--	381	--	992	37,900
Missouri	--	--	911	W	W	--	911	3,290
Montana	--	102	W	--	--	--	102	8,400
Nebraska	--	--	133	--	--	--	133	W
Nevada	--	W	--	--	25	W	25	4,520
New Jersey	--	--	W	--	--	--	W	122
New Mexico	--	--	34	--	--	--	34	177
New York	--	--	756	--	--	--	756	10,900
North Carolina	--	--	2,260	--	--	34	2,290	13,600
North Dakota	--	--	W	--	--	--	W	189
Ohio	--	--	1,360	W	--	--	1,360	7,480
Oklahoma	--	--	1,150	--	--	--	1,150	2,410
Oregon	--	W	W	--	--	--	W	450
Pennsylvania	--	--	822	--	--	--	822	3,270
South Carolina	--	--	1,040	W	--	296	1,330	22,500
South Dakota	--	--	188	--	--	--	188	743
Tennessee	762	--	365	--	W	W	1,130	37,500
Texas	W	W	2,160	--	W	W	2,160	8,890
Utah	--	73	443	--	--	--	515	5,600
Virginia	--	W	994	--	W	--	994	4,640
Washington	--	--	W	--	--	--	W	W
West Virginia	--	--	161	--	--	--	161	441
Wyoming	--	3,510	49	--	--	--	3,550	151,000
Grand total	1,220	4,060	24,600	307	3,260	7,760	41,200	1,680,000

W Withheld to avoid disclosing company proprietary data; included in "Grand total." -- Zero.

<sup>1</sup>Excludes Puerto Rico.<sup>2</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

TABLE 3

BALL CLAY SOLD OR USED BY PRODUCERS IN THE UNITED STATES, BY STATE<sup>1</sup>

(Thousand metric tons and thousand dollars)

State	Airfloat		Water-slurried		Unprocessed		Grand total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
2003:								
Tennessee	312	15,800	197	8,460	257	9,140	766	33,400
Other <sup>2</sup>	268	14,800	W	W	W	W	543	22,800
Total	580	30,500	197	8,460	257	9,140	1,310	56,200
2004:								
Tennessee	308	16,200	198	9,400	256	8,740	762	34,300
Other <sup>2</sup>	229	12,500	W	W	W	W	462	19,800
Total	537	28,600	198	9,400	256	8,740	1,220	54,100

W Withheld to avoid disclosing company proprietary data; included in "Grand total."

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.<sup>2</sup>Includes Indiana, Kentucky, Mississippi, and Texas.

TABLE 4  
BALL CLAY SOLD OR USED BY PRODUCERS IN THE UNITED STATES, BY USE<sup>1</sup>

(Metric tons)

Use	2003	2004
Fillers, extenders, binders <sup>2</sup>	85,800	86,500
Floor and wall tile	409,000	428,000
Miscellaneous ceramics <sup>3</sup>	230,000	203,000
Pottery	21,000	26,500
Refractories <sup>4</sup>	66,600	W
Sanitaryware	267,000	322,000
Miscellaneous <sup>5</sup>	78,100	44,700
Exports <sup>6</sup>	152,000	114,000
Total	1,310,000	1,220,000

W Withheld to avoid disclosing company proprietary data; included in "Miscellaneous."

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Includes adhesives animal feed, asphalt tile, asphalt emulsions, gypsum, paper filling, pesticides and related products, plastics, rubber, and other fillers, extenders, and binders.

<sup>3</sup>Includes catalysts, electrical porcelain, fiberglass, fine china/dinnerware, glass, mineral wool, roofing granules, and miscellaneous ceramics.

<sup>4</sup>Includes firebrick, blocks, shapes, high-alumina specialties, and kiln furniture.

<sup>5</sup>Includes heavy clay products, waterproofing seals, and other unknown uses.

<sup>6</sup>Includes ceramics and glass and floor and wall tile.

TABLE 5  
BENTONITE SOLD OR USED BY PRODUCERS IN THE UNITED STATES, BY STATE<sup>1</sup>

(Thousand metric tons and thousand dollars)

State	Nonswelling		Swelling		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
2003:						
Wyoming	--	--	3,330 <sup>r</sup>	142,000 <sup>r</sup>	3,330 <sup>r</sup>	142,000 <sup>r</sup>
Other <sup>2</sup>	238	9,840	201 <sup>r</sup>	12,800 <sup>r</sup>	440 <sup>r</sup>	22,700 <sup>r</sup>
Total	238	9,840	3,530 <sup>r</sup>	155,000 <sup>r</sup>	3,770 <sup>r</sup>	164,000 <sup>r</sup>
2004:						
Wyoming	--	--	3,510	151,000	3,510	151,000
Other <sup>2</sup>	320	14,200	236	14,400	556	28,600
Total	320	14,200	3,740	165,000	4,060	180,000

<sup>r</sup>Revised. -- Zero.

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Includes Alabama, Arizona, California, Colorado, Mississippi, Montana, Nevada, Oregon, Texas, Utah, and Virginia.

TABLE 6  
BENTONITE SOLD OR USED BY PRODUCERS IN THE UNITED STATES, BY USE<sup>1</sup>

(Metric tons)

Use	2003	2004
Domestic:		
Absorbents:		
Pet waste absorbents	888,000 <sup>r</sup>	944,000
Other absorbents	W	W
Adhesives	5,560 <sup>r</sup>	2,240
Animal feed	49,600 <sup>r</sup>	44,500
Ceramics (except refractories) <sup>2</sup>	W	W
Drilling mud	772,000 <sup>r</sup>	776,000
Filler and extender applications <sup>3</sup>	41,300	39,000
Filtering, clarifying, decolorizing	W	W
Foundry sand	761,000 <sup>r</sup>	745,000
Pelletizing (iron ore) <sup>4</sup>	511,000 <sup>r</sup>	526,000
Miscellaneous refractories	W	--
Miscellaneous <sup>5</sup>	356,000 <sup>r</sup>	560,000
Waterproofing and sealing	W	W
Total	3,380,000 <sup>r</sup>	3,640,000
Exports:		
Drilling mud	56,700 <sup>r</sup>	58,200
Foundry sand	217,000 <sup>r</sup>	217,000
Other <sup>6</sup>	108,000	149,000
Total	382,000 <sup>r</sup>	424,000
Grand total	3,770,000 <sup>r</sup>	4,060,000

<sup>r</sup>Revised. W Withheld to avoid disclosing company proprietary data; included with "Miscellaneous." -- Zero.

<sup>1</sup>Data are rounded to no more than three significant digits, may not add to totals shown.

<sup>2</sup>Includes catalysts and pottery.

<sup>3</sup>Includes asphalt tiles, cosmetics, ink, medical, miscellaneous fillers and extenders applications, paint, paper coating, paper filling, pesticides and related products, pharmaceuticals, and plastics.

<sup>4</sup>Excludes shipments to Canada. Total sales in North America were 600,000 metric tons in 2003 and 2004.

<sup>5</sup>Includes chemical manufacturing, heavy clay products, and other unknown uses.

<sup>6</sup>Includes absorbents, fillers and extenders, miscellaneous refractories, pelletizing, and other unknown uses.

TABLE 7  
COMMON CLAY AND SHALE SOLD OR USED BY PRODUCERS  
IN THE UNITED STATES, BY STATE<sup>1, 2</sup>

(Thousand metric tons and thousand dollars)

State	2003		2004	
	Quantity	Value	Quantity	Value
Alabama	1,890 <sup>r</sup>	24,000	2,120	29,600
Arkansas	897	1,410	1,150	1,510
California	1,240	19,100	1,230	20,700
Georgia	1,280	4,430	1,550	8,710
Indiana	385	767	729	8,910
Kansas	632	10,000	621	7,460
Kentucky	983	3,770	978	4,510
Michigan	588	3,050	605	3,070
Mississippi	524	2,050	610	2,700
Missouri	970	3,660	911	3,290
New York	644	8,050	756	10,900
North Carolina	2,190	10,900	2,260	12,900
Ohio	1,440	7,430	1,360	7,480
Oklahoma	1,160	2,390	1,150	2,410
Pennsylvania	750	2,240	822	3,270
South Carolina	1,060	2,660	1,040	2,860
Texas	2,110	8,890	2,160	8,890
Virginia	958	2,530	994	4,640
Other <sup>3</sup>	3,370	14,200	3,510	29,400
Total	23,100	131,000	24,600	173,000

<sup>r</sup>Revised.

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Excludes Puerto Rico.

<sup>3</sup>Includes all other States except Alaska, Delaware, Hawaii, Idaho, Nevada, New Hampshire, Rhode Island, Vermont, and Wisconsin.

TABLE 8

COMMON CLAY AND SHALE SOLD OR USED BY PRODUCERS IN THE UNITED STATES, BY USE<sup>1, 2</sup>

(Metric tons)

Use	2003	2004
Ceramics and glass <sup>3</sup>	207,000	405,000
Civil engineering and sealing	12,500	W
Floor and wall tile:		
Ceramic	342,000	370,000
Other <sup>4</sup>	99,600	38,500
Heavy clay products:		
Brick, extruded	11,200,000 <sup>r</sup>	12,700,000
Brick, other	1,600,000 <sup>r</sup>	1,650,000
Drain tile and sewer pipe	(5)	W
Flowerpots	43,100	W
Flue linings	146,000	W
Structural tile	(5)	W
Terra cotta	272,000	--
Other <sup>6</sup>	354,000	237,000
Lightweight aggregate:		
Concrete block	2,250,000	2,160,000
Highway surfacing	344,000	323,000
Structural concrete	799,000	758,000
Miscellaneous <sup>7</sup>	320,000	522,000
Portland and other cements	4,350,000	4,200,000
Refractories <sup>8</sup>	523,000	749,000
Miscellaneous <sup>9</sup>	285,000	458,000
Total	23,200,000 <sup>r</sup>	24,600,000

<sup>r</sup>Revised. W Withheld to avoid disclosing company proprietary data; included with "Miscellaneous." -- Zero.<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.<sup>2</sup>Excludes Puerto Rico.<sup>3</sup>Includes pottery and roofing granules.<sup>4</sup>Includes quarry tile and miscellaneous floor and wall tiles.<sup>5</sup>Withheld to avoid disclosing company proprietary data; included with "Heavy clay products, other."<sup>6</sup>Includes drain tile, flower pots, roofing tile, sewer pipe, structural tile, and miscellaneous clay products.<sup>7</sup>Includes miscellaneous lightweight aggregates.<sup>8</sup>Includes firebrick, blocks and shapes, mortar and cement, plugs, taps, wads, and miscellaneous refractories.<sup>9</sup>Includes exports; miscellaneous civil engineering and sealings; miscellaneous fillers, extenders, and binders; wallboard; and other unknown uses and uses indicated with symbol W.



TABLE 9  
FIRE CLAY SOLD OR USED BY PRODUCERS IN  
THE UNITED STATES, BY STATE<sup>1</sup>

(Thousand metric tons and thousand dollars)

State	2003		2004	
	Quantity	Value	Quantity	Value
Missouri	251 <sup>r</sup>	6,540 <sup>r</sup>	W	W
Other <sup>2</sup>	93	2,950	W	W
Total	345 <sup>r</sup>	9,500 <sup>r</sup>	307	8,510

<sup>r</sup>Revised. W Withheld to avoid disclosing company  
proprietary data.

<sup>1</sup>Data are rounded to no more than three significant digits;  
may not add to totals shown.

<sup>2</sup>Includes Ohio, and South Carolina.

TABLE 10  
FIRE CLAY SOLD OR USED BY PRODUCERS IN THE UNITED STATES, BY USE<sup>1</sup>

(Metric tons)

Use	2003	2004
Heavy clay products and lightweight aggregates <sup>2</sup>	W	W
Refractories:		
Firebrick, block, shapes	W	--
Other refractories <sup>3</sup>	291,000 <sup>r</sup>	165,000
Miscellaneous <sup>4</sup>	54,000 <sup>r</sup>	142,000
Total	345,000 <sup>r</sup>	307,000

<sup>r</sup>Revised. W Withheld to avoid disclosing company proprietary data; included with "Miscellaneous." -- Zero.

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Includes common brick and portland cement.

<sup>3</sup>Includes foundry sand, grogs and calcines, kiln furniture (2004), mortar and cement, and miscellaneous refractories.

<sup>4</sup>Includes miscellaneous lightweight aggregates, and other unknown uses.

TABLE 11  
FULLER'S EARTH SOLD OR USED BY PRODUCERS IN THE UNITED STATES, BY STATE<sup>1</sup>

(Thousand metric tons and thousand dollars)

State	Attapulgit <sup>2</sup>		Montmorillonite		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
2003:						
Georgia	W	W	W	W	1,460 <sup>r</sup>	146,000 <sup>r</sup>
Southern States <sup>3</sup>	W	W	W	W	708 <sup>r</sup>	37,700 <sup>r</sup>
Western States <sup>4</sup>	W	W	W	W	1,430 <sup>r</sup>	162,000 <sup>r</sup>
Total	244	29,900	3,360	316,000	3,610 <sup>r</sup>	346,000
2004:						
Georgia	W	W	W	W	1,400	142,000
Southern States <sup>3</sup>	W	W	W	W	976	103,000
Western States <sup>4</sup>	W	W	W	W	887	84,300
Total	237	30,100	3,020	299,000	3,260	329,000

<sup>r</sup>Revised. W Withheld to avoid disclosing company proprietary data; included with "Total."

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Primarily gellant-grade fuller's earth. More information can be found in the "Fuller's Earth" portion of the "Production" section of this report.

<sup>3</sup>Includes Florida, Mississippi, Tennessee, and Virginia.

<sup>4</sup>Includes California, Illinois, Kansas, Missouri, Nevada, and Texas.

TABLE 12  
FULLER'S EARTH SOLD OR USED BY PRODUCERS IN THE UNITED STATES, BY USE<sup>1</sup>

(Metric tons)

Use	2003	2004
Absorbents:		
Oil and grease absorbent	353,000	295,000
Pet waste absorbent	2,400,000	2,250,000
Animal feed	113,000	W
Fertilizers	49,600	46,400
Fillers, extenders, binders <sup>2</sup>	53,200	127,000
Filtering, clarifying, and decolorizing animal, mineral, and vegetable oils and greases	66,200	67,100
Pesticides and related products	134,000	W
Miscellaneous <sup>3</sup>	408,000	477,000
Exports <sup>4</sup>	31,800	W
Total	3,600,000	3,260,000

W Withheld to avoid disclosing company proprietary data; included with "Miscellaneous."

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Includes adhesives, asphalt emulsions, asphalt tiles, gypsum products, medical, pharmaceuticals and cosmetics, paints, paper coating, textiles, and other unknown uses.

<sup>3</sup>Includes drilling mud, portland cement, refractories, roofing granules, and other unknown uses.

<sup>4</sup>Includes absorbents; fillers, extenders, and binders; floor and wall tiles; and refractories.

TABLE 13  
KAOLIN SOLD OR USED BY PRODUCERS IN THE UNITED  
STATES, BY STATE<sup>1</sup>

(Thousand metric tons and thousand dollars)

Use	2003		2004	
	Quantity	Value	Quantity	Value
Georgia	6,610	884,000	6,780	889,000
South Carolina	355	21,700	296	19,600
Other <sup>2</sup>	712	32,400 <sup>r</sup>	684	27,200
Total	7,680	938,000 <sup>r</sup>	7,760	936,000

<sup>r</sup>Revised.

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Includes Alabama, Arkansas, California, Florida, Nevada, North Carolina, Tennessee, and Texas.

TABLE 14  
KAOLIN SOLD OR USED BY PRODUCERS IN THE UNITED  
STATES, BY KIND<sup>1</sup>

(Thousand metric tons and thousand dollars)

Kind	2003		2004	
	Quantity	Value	Quantity	Value
Airfloat	943	53,100	1,150	62,400
Calcined <sup>2</sup>	1,420 <sup>r</sup>	261,000 <sup>r</sup>	1,400	267,000
Delaminated	1,130	144,000	1,240	156,000
Unprocessed	171 <sup>r, 3</sup>	2,450 <sup>r, 3</sup>	101	1,850
Water washed	4,010	478,000	3,870	449,000
Total	7,680	938,000 <sup>r</sup>	7,760	936,000

<sup>r</sup>Revised.

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Includes pigment- and refractory-grade calcined kaolin.

<sup>3</sup>Includes a small amount of pigment-grade.

TABLE 15  
CALCINED KAOLIN SOLD OR USED BY PRODUCERS IN  
THE UNITED STATES, BY STATE<sup>1</sup>

(Thousand metric tons and thousand dollars)

State	Refractory-grade		Pigment-grade	
	Quantity	Value	Quantity	Value
2003:				
Georgia	W	W	W	W
Other <sup>2</sup>	W	W	W	W
Total	591	17,500 <sup>r</sup>	827 <sup>r</sup>	244,000 <sup>r</sup>
2004:				
Georgia	W	W	W	W
Other <sup>2</sup>	W	W	W	W
Total	547	16,500	853	250,000

<sup>r</sup>Revised. W Withheld to avoid disclosing company proprietary data; included in "Total."

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Includes Alabama, California, South Carolina, and Texas.

TABLE 16  
GEORGIA KAOLIN SOLD OR USED BY PRODUCERS, BY KIND<sup>1</sup>

(Thousand metric tons and thousand dollars)

Kind	2003		2004	
	Quantity	Value	Quantity	Value
Airfloat	593 <sup>e</sup>	28,000 <sup>e</sup>	851 <sup>e</sup>	41,300 <sup>e</sup>
Calcined <sup>2</sup>	883	239,000	906	245,000
Delaminated	1,130	144,000	1,240	156,000
Unprocessed	59 <sup>e</sup>	609 <sup>e</sup>	W	W
Water washed	3,940	472,000	3,780	447,000
Total	6,610	884,000	6,780	889,000

<sup>e</sup>Estimated. W Withheld to avoid disclosing company proprietary data; included in "Water washed."

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Includes pigment- and refractory-grade calcined kaolin.



TABLE 17  
GEORGIA KAOLIN SOLD OR USED BY PRODUCERS, BY USE<sup>1, 2</sup>

(Metric tons)

Use	2003	2004
Domestic:		
Ceramics and glass:		
Catalysts (oil-refining)	W	W
Fiberglass	265,000	290,000
Roofing granules	20,100	W
Sanitaryware	76,900	W
Other <sup>3</sup>	45,700	347,000
Fillers, extenders, binders:		
Adhesives	51,500	40,100
Paint	253,000	273,000
Paper coating	2,440,000	2,470,000
Paper filling	437,000	465,000
Plastic	43,800	84,500
Rubber	59,500	94,900
Other <sup>4</sup>	90,400	77,600
Heavy clay products <sup>5</sup>	W	W
Refractories <sup>6</sup>	239,000	266,000
Undistributed <sup>7</sup>	270,000	107,000
Total	4,290,000	4,510,000
Exports:		
Paint	82,600	73,400
Paper coating <sup>8</sup>	1,970,000	1,920,000
Paper filling <sup>8</sup>	91,300	129,000
Rubber	6,700	10,600
Undistributed <sup>9</sup>	171,000	126,000
Total	2,320,000	2,260,000
Grand total	6,610,000	6,780,000

W Withheld to avoid disclosing company proprietary data; included with "Domestic, undistributed."

<sup>1</sup>Includes airfloat, high- and low-temperature calcined delaminated, water washed, and unprocessed kaolin.

<sup>2</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>3</sup>Includes electrical porcelain, fine china/dinnerware, pottery, and miscellaneous ceramics, roofing granules, and sanitaryware.

<sup>4</sup>Includes animal feed, asphalt tile, fertilizers, gypsum products, medical, pharmaceuticals and cosmetics, pesticides and related products, textiles, and miscellaneous fillers, extenders, and binders.

<sup>5</sup>Includes brick (common and face), portland cement, and miscellaneous clay products.

<sup>6</sup>Includes firebricks, blocks and shapes, grogs and calcines, high-alumina specialties, kiln furniture, and miscellaneous refractories.

<sup>7</sup>Includes absorbents, chemical manufacturing, floor and wall tiles, catalysts (oil-refining), heavy clay products, waterproofing seals, and other unknown uses.

<sup>8</sup>Some export sales may be included under domestic sales.

<sup>9</sup>Includes adhesives, catalysts (oil-refining), fiberglass, sanitaryware; miscellaneous fillers, extenders, and binders; portland cement; and miscellaneous refractories.

TABLE 18  
SOUTH CAROLINA KAOLIN SOLD OR USED BY PRODUCERS, BY KIND<sup>1</sup>

(Thousand metric tons and thousand dollars)

Kind	2003		2004	
	Quantity	Value	Quantity	Value
Airfloat <sup>2</sup>	355	21,700	296	19,600
Unprocessed <sup>3</sup>	W	W	W	W
Total	355	21,700	296	19,600

<sup>1</sup>Revised. W Withheld to avoid disclosing company proprietary data; included in "Airfloat."

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Includes unprocessed kaolin.

<sup>3</sup>Includes calcined kaolin.

TABLE 19  
SOUTH CAROLINA KAOLIN SOLD OR USED BY PRODUCERS, BY KIND AND USE<sup>1</sup>

(Metric tons)

Kind and use	2003	2004
Adhesives	20,200	15,600
Ceramics <sup>2</sup>	107,000	107,000
Rubber	112,000	87,600
Refractories <sup>3</sup>	5,890	5,650
Other uses <sup>4</sup>	67,900	52,100
Exports <sup>5</sup>	41,800	27,400
Total	355,000	296,000

<sup>1</sup>Revised.

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Includes catalysts (oil-refining), fine china/dinnerware, glazes, glass, and enamels, pottery, roofing granules, sanitaryware, and miscellaneous ceramics.

<sup>3</sup>Includes firebrick, blocks and shapes, and miscellaneous refractories.

<sup>4</sup>Includes asphalt tile; brick (common and face); catalysts (oil refining); chemical manufacturing; civil engineering and sealings; drilling mud; fillers, extenders, and binders; heavy clay products, lightweight aggregates; paints; and plastics.

<sup>5</sup>Includes refractories and fillers, extenders, and binders.

TABLE 20  
KAOLIN SOLD OR USED BY PRODUCERS IN THE UNITED STATES, BY USE<sup>1</sup>

(Metric tons)

Use	2003	2004
Domestic:		
Ceramics:		
Catalyst (oil and gas refining)	209,000	182,000
Electrical porcelain	7,850	W
Fine china and dinnerware	30,500	24,800
Floor and wall tile	61,900	70,700
Pottery	13,800	9,260
Roofing granules	36,100	71,000
Sanitaryware	85,300	32,800
Miscellaneous	W	W
Chemical manufacture	34,900	60,300
Civil engineering	W	W
Fiberglass, mineral wool	288,000	317,000
Fillers, extenders, binders:		
Adhesive	71,700	55,800
Fertilizer	3,490	W
Medical, pharmaceutical, cosmetic	745	751
Paint	284,000	313,000
Paper coating	2,450,000	2,470,000
Paper filling	438,000	465,000
Pesticide	W	W
Plastic	47,200	104,000
Rubber	172,000	183,000
Miscellaneous	103,000	78,700
Heavy clay products:		
Brick, common and face	95,000	97,100
Portland cement	58,400	57,200
Refractories <sup>2</sup>	320,000 <sup>r</sup>	732,000
Miscellaneous applications	68,600	142,000
Total	4,880,000 <sup>r</sup>	5,460,000
Exports:		
Ceramics	152,000	W
Paint	82,600	73,400
Paper coating	1,970,000	1,920,000
Paper filling	91,300	129,000
Rubber	48,000	38,000
Miscellaneous	21,700	128,000
Total	2,360,000	2,290,000
Grand total	7,240,000 <sup>r</sup>	7,760,000

<sup>r</sup>Revised. W Withheld to avoid disclosing company proprietary data; included with "Domestic Fillers, extenders, binders, miscellaneous" or "Domestic, Miscellaneous applications" or "Export miscellaneous."

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Includes firebrick (blocks and shapes), grogs and calcines, high-alumina kaolin (brick and specialties), kiln furniture, and miscellaneous refractories.

TABLE 21  
COMMON CLAY AND SHALE USED IN LIGHTWEIGHT AGGREGATE  
PRODUCTION IN THE UNITED STATES BY STATE<sup>1</sup>

(Thousand metric tons and thousand dollars)

State	Concrete block	Structural concrete	Other <sup>2</sup>	Total	
				Quantity	Value <sup>c</sup>
2003:					
Alabama	575	41	68	685	18,200
Arkansas	201	50	--	251	346
California	48	179	--	227	11,100
Florida	68	23	--	91	1,280
Indiana	137	8	--	145	295
Kansas	--	--	80	80	1,110
Kentucky	109	36	--	145	557
Louisiana	319	159	53	531	1,170
Missouri	--	--	114	114	1,700
New York	82	54	--	136	5,600
North Carolina <sup>c</sup>	301	52	--	353	4,050
Ohio <sup>c</sup>	149	8	--	157	764
Oklahoma	22	3	--	25	659
Texas <sup>c</sup>	49	157	253	459	2,520
Utah	48	27	95	170	2,870
Virginia	141	--	--	141	980
Total	2,250	799	664	3,710	53,200
2004:					
Alabama	759	54	90	904	24,200
Arizona	--	17	--	17	19
Arkansas	425	--	--	425	704
California	39	214	--	253	11,200
Florida <sup>c</sup>	68	23	--	91	1,280
Indiana <sup>c</sup>	130	35	71	236	7,500
Kansas	--	--	67	67	931
Kentucky <sup>c</sup>	109	36	--	145	557
Louisiana <sup>c</sup>	136	43	94	273	10,500
Missouri	--	--	101	101	1,500
New York <sup>c</sup>	82	96	--	178	7,840
North Carolina <sup>c</sup>	144	--	10	154	1,940
Ohio <sup>c</sup>	149	8	--	157	764
Oklahoma <sup>c</sup>	22	3	--	25	659
Texas <sup>c</sup>	49	157	253	459	2,520
Utah	49	71	159	279	5,210
Total	2,160	758	845	3,760	77,300

<sup>c</sup>Estimated. -- Zero.

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Includes highway surfacing.

TABLE 22  
COMMON CLAY AND SHALE USED IN BUILDING BRICK  
PRODUCTION IN THE UNITED STATES, BY STATE<sup>1, 2</sup>

(Thousand metric tons and thousand dollars)

State	2003		2004	
	Quantity	Value <sup>c</sup>	Quantity	Value <sup>c</sup>
Alabama	536 <sup>r</sup>	1,780 <sup>r</sup>	568	1,820
Arkansas	459	520	460	518
California	314	1,010	314	1,010
Colorado	209	1,400	199	1,320
Georgia	1,130	3,430	1,390	7,640
Illinois	169	914	240	1,310
Kentucky <sup>3</sup>	469	1,330	464	2,070
Maryland	201	244	194	264
Mississippi	448	1,920	534	2,570
North Carolina	1,730	5,540	2,030	6,200
Ohio	602	2,890	826	4,550
Oklahoma	797	1,240	834	1,310
Pennsylvania	709	2,060	768	3,070
South Carolina	880	2,450 <sup>r</sup>	760	1,400
Texas	902	3,970	967	4,060
Other <sup>4</sup>	3,280	15,200 <sup>r</sup>	3,790	20,300
Total	12,800 <sup>r</sup>	45,900 <sup>r</sup>	14,300	59,500

<sup>c</sup>Estimated. <sup>r</sup>Revised.

<sup>1</sup>Includes extruded and other brick.

<sup>2</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>3</sup>Extruded brick only.

<sup>4</sup>Includes all other States except Alaska, Delaware, Hawaii, Idaho, Nevada, New Hampshire, Rhode Island, Vermont, and Wisconsin.

TABLE 23  
U.S. EXPORTS OF CLAYS IN 2004, BY COUNTRY<sup>1</sup>

(Thousand metric tons and thousand dollars)

Country	Ball clay		Bentonite		Fire clay		Fuller's earth		Kaolin		Clays, n.e.c. <sup>2</sup>		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Argentina	(3)	31	(3)	13	(3)	49	1	175	10	2,490	2	2,220	12	4,980
Australia	--	--	11	1,100	8	955	(3)	49	11	3,910	9	8,560	40	14,600
Belgium	(3)	47	30	6,620	--	--	1	100	46	13,100	4	2,460	82	22,300
Brazil	1	5	11	1,420	(3)	11	1	44	6	2,480	3	2,830	22	7,190
Canada	58	2,900	290	22,100	10	1,320	7	1,340	815	93,900	299	45,000	1,480	167,000
China	1	324	17	1,190	2	358	(3)	45	213	35,800	3	3,810	237	41,600
Colombia	--	--	2	337	(3)	28	3	603	11	4,520	1	643	16	6,120
Finland	2	1,060	4	317	--	--	(3)	66	320	59,700	1	282	327	61,400
France	--	--	(3)	434	(3)	102	(3)	21	4	1,910	4	1,780	8	4,240
Germany	--	--	9	785	--	--	1	223	63	18,500	8	3,290	81	22,800
India	(3)	5	1	150	1	210	(3)	133	15	3,460	5	2,390	22	6,340
Indonesia	--	--	21	3,770	(3)	61	--	--	84	19,200	2	1,640	107	24,700
Italy	--	--	1	822	--	--	1	513	132	19,500	7	2,970	141	23,800
Japan	2	254	239	20,900	20	1,960	--	--	838	129,000	48	16,600	1,150	169,000
Korea, Republic of	1	132	11	1,980	1	193	(3)	134	152	31,100	14	9,520	179	43,100
Malaysia	--	--	26	2,570	--	--	2	204	4	947	3	1,380	34	5,100
Mexico	1	55	28	3,070	153	13,600	3	552	206	19,600	42	8,280	433	45,200
Netherlands	1	379	29	12,900	--	--	9	863	146	23,500	19	18,900	205	56,500
Philippines	1	39	1	308	--	--	(3)	44	39	8,270	2	933	43	9,590
Saudi Arabia	--	--	16	2,630	(3)	4	(3)	304	1	1,070	2	1,090	19	5,100
Singapore	--	--	1	583	--	--	(3)	32	3	1,240	7	3,530	11	5,390
South Africa	--	--	(3)	260	(3)	24	(3)	48	3	1,140	6	1,940	9	3,410
Sweden	--	--	(3)	75	1	89	(3)	31	86	17,700	8	1,870	95	19,800
Taiwan	5	280	42	6,010	15	1,040	(3)	8	207	29,500	7	3,850	276	40,700
Thailand	--	--	18	1,170	(3)	4	(3)	48	29	7,940	6	2,960	53	12,100
United Kingdom	1	62	58	5,780	(3)	7	2	384	37	9,430	9	8,480	108	24,100
Venezuela	15	1,250	8	879	(3)	104	2	471	41	13,600	4	1,610	71	17,900
Other	19	1,380	41	6,560	122	12,200	16	3,860	122	27,000	61	22,100	376	72,700
Total	107	8,200	915	105,000	332	32,300	49	10,300	3,640	600,000	586	181,000	5,630	936,000

-- Zero.

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Also includes chamotte or dina's earth, activated clays and earths, and artificially activated clays.

<sup>3</sup>Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 24  
U.S. IMPORTS FOR CONSUMPTION OF CLAY IN 2004, BY KIND<sup>1</sup>

Kind	Quantity (metric tons)	Value <sup>2</sup> (thousands)
China clay or kaolin:		
Brazil	187,000	\$31,400
Canada	658	257
France	497	204
Germany	79	187
Japan	78	120
Mexico	612	223
Ukraine	1,200	362
United Kingdom	14,800	5,800
Other	44	73
Total	205,000	38,600
Fire clay:		
Canada	253	80
Germany	10	46
South Africa	5,600	1,530
Other	60	19
Total	5,920	1,680
Decolorizing earths and fuller's earth:		
Australia	45	2
China	182	46
Total	227	48
Bentonite:		
Argentina	416	70
Canada	5,350	1,670
China	218	176
France	209	77
Greece	1,000	58
Japan	37	44
Mexico	1,100	580
Netherlands	241	160
Spain	9	21
Turkey	430	205
United Kingdom	318	228
Other	16	69
Total	9,340	3,360
Common blue clay and other ball clay:		
China	13	25
Spain	1	7
United Kingdom	506	186
Total	520	218
Other clay:		
Canada	1,660	329
China	111	154
France	208	116
Germany	1,970	1,650
Mexico	265	331
Netherlands	148	128
Spain	444	441
United Kingdom	465	272
Other	171	221
Total	5,430	3,650
Chamotte or dina's earth, Spain	2	2

See footnotes at end of table.



TABLE 24—Continued  
U.S. IMPORTS FOR CONSUMPTION OF CLAY IN 2004, BY KIND<sup>1</sup>

Kind	Quantity (metric tons)	Value <sup>2</sup> (thousands)
Artificially activated clay and activated earth:		
Australia	205	\$72
Canada	10,500	5,890
China	81	98
Denmark	64	155
Germany	3,440	2,880
Mexico	9,730	3,830
Netherlands	407	242
Norway	153	194
United Kingdom	16	379
Venezuela	143	73
Other	125	358
Total	24,900	14,200
Grand total	251,000	61,700

<sup>1</sup>Data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>U.S. customs declared value.

Source: U.S. Census Bureau.

TABLE 25  
BENTONITE: WORLD PRODUCTION, BY COUNTRY<sup>1,2</sup>

(Metric tons)

Country <sup>3</sup>	2000	2001	2002	2003	2004 <sup>c</sup>
Algeria <sup>4</sup>	22,708	21,286	27,178	25,346	30,319 <sup>5</sup>
Argentina	123,092	135,450	120,006	146,845 <sup>r</sup>	163,028 <sup>5</sup>
Armenia	2,807	1,000 <sup>e</sup>	258	642 <sup>e</sup>	642
Australia <sup>c,4</sup>	180,000	180,000	200,000	200,000	200,000
Bosnia and Herzegovina	5 <sup>r, e</sup>	5 <sup>r, e</sup>	9,829 <sup>r</sup>	13,050 <sup>r</sup>	16,500
Brazil, beneficiated	273,975 <sup>r</sup>	178,610 <sup>r</sup>	184,909 <sup>r</sup>	199,212 <sup>r</sup>	200,000
Bulgaria	296,000	320,000 <sup>e</sup>	212,000 <sup>r</sup>	146,000 <sup>r</sup>	150,000
Burma	978	900 <sup>e</sup>	900	900 <sup>e</sup>	900
Chile	1,314	1,695	632 <sup>r</sup>	748 <sup>r</sup>	750
Commonwealth of Independent States <sup>c,6</sup>	750,000	750,000	750,000	750,000	750,000
Croatia	10,013	10,580	12,102 <sup>r</sup>	13,568 <sup>r</sup>	13,500
Cyprus	167,500	126,600	128,400	144,859 <sup>r</sup>	150,000
Czech Republic	280,000	224,000 <sup>e</sup>	174,000	175,000 <sup>e</sup>	175,000
Egypt <sup>c</sup>	50,000	50,000	50,000	50,000	50,000
Georgia <sup>c</sup>	7,084	7,000	7,000	9,700 <sup>r</sup>	1,800 <sup>5</sup>
Germany <sup>c</sup>	465,000 <sup>r</sup>	448,000 <sup>r</sup>	495,000 <sup>r</sup>	479,000 <sup>r</sup>	405,000 <sup>5</sup>
Greece <sup>c</sup>	950,000	950,000	950,000	950,000	950,000
Guatemala	3,317	3,000 <sup>e</sup>	4,436 <sup>r</sup>	6,438 <sup>r</sup>	6,450
Hungary	4,800	5,200 <sup>e</sup>	3,700 <sup>r</sup>	3,500 <sup>r</sup>	3,500
Indonesia <sup>c</sup>	5,000	5,000	5,000	5,000	5,000
Iran <sup>7</sup>	70,000	80,000	80,000	80,000 <sup>e</sup>	80,000
Italy <sup>c</sup>	500,000	500,000 <sup>e</sup>	500,000	500,000	500,000
Kenya	64	50	50	50 <sup>e</sup>	50
Japan	415,115	405,738	437,772 <sup>r</sup>	425,945 <sup>r</sup>	430,000
Macedonia <sup>c</sup>	30,000	30,000	25,000 <sup>r</sup>	25,000 <sup>r</sup>	25,000
Mexico	269,730	415,133	488,215 <sup>r</sup>	464,056 <sup>r</sup>	470,000
Morocco	43,152	71,741	58,754	71,544	71,500
Mozambique	16,144	1,357	--	--	3,336 <sup>5</sup>
New Zealand, processed <sup>c</sup>	10,000	10,000	7,800	7,800 <sup>5</sup>	7,800
Pakistan	27,700	27,000 <sup>e</sup>	28,000	28,000 <sup>e</sup>	30,000
Peru	21,059	18,217	20,760	14,900	18,471 <sup>5</sup>
Philippines	2,800	5,128	5,500	5,000 <sup>e</sup>	5,000
Poland <sup>8</sup>	29,700	29,000	26,200	27,000 <sup>e</sup>	27,000
Romania	35,789	24,779	15,389 <sup>r</sup>	17,637 <sup>r</sup>	18,000
Serbia and Montenegro <sup>c</sup>	75	75	75 <sup>5</sup>	75	75
Slovakia	66,528 <sup>r</sup>	82,915 <sup>r</sup>	66,128 <sup>r</sup>	74,938 <sup>r</sup>	70,000
South Africa <sup>9</sup>	85,187	116,384	218,512	145,060	55,859 <sup>5</sup>
Spain <sup>c</sup>	150,000	150,000	150,000	150,000	150,000
Turkey	636,273	674,175	559,224	831,146 <sup>r</sup>	850,000
Turkmenistan <sup>c</sup>	50,000	50,000	50,000	50,000	50,000
Ukraine <sup>c</sup>	300,000	300,000	300,000	300,000	300,000
United States	3,760,000	3,970,000	3,970,000	3,770,000 <sup>r</sup>	4,060,000 <sup>5</sup>
Zimbabwe <sup>9</sup>	140,000 <sup>e</sup>	--	--	--	--
Total	10,300,000 <sup>r</sup>	10,400,000	10,300,000	10,300,000 <sup>r</sup>	10,500,000

<sup>c</sup>Estimated. <sup>r</sup>Revised. -- Zero.

<sup>1</sup>World totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Table includes data available through August 21, 2005.

<sup>3</sup>In addition to the countries listed, Canada and China are believed to produce bentonite, but output is not reported, and available information is inadequate to make reliable estimates of output levels.

<sup>4</sup>Includes bentonitic clays.

<sup>5</sup>Reported figure.

<sup>6</sup>Information is inadequate to formulate reliable estimates for individual countries, except Armenia, Georgia, Turkmenistan, and Ukraine.

<sup>7</sup>Year beginning March 21 of that stated.

<sup>8</sup>Montmorillite type bleaching clay.

<sup>9</sup>May include other clays.

TABLE 26  
FULLER'S EARTH: WORLD PRODUCTION, BY COUNTRY<sup>1,2</sup>

(Metric tons)

Country <sup>3</sup>	2000	2001	2002	2003	2004 <sup>c</sup>
Algeria	3,431	3,254	3,521	2,573	2,284 <sup>4</sup>
Argentina <sup>c</sup>	1,500	1,500	1,500	1,500	1,500
Australia, attapulgite	5,600	5,600	6,000	6,000 <sup>e</sup>	6,000
Germany, unprocessed <sup>c</sup>	500,000	500,000	500,000	500,000	500,000
Italy <sup>c</sup>	30,000	30,000	30,000	30,000	30,000
Mexico	51,685	148,194	147,064	152,917	155,000
Morocco, smectite	30,665	40,664	43,243	14,944	15,000
Pakistan	15,288	15,000 <sup>e</sup>	15,000	15,000 <sup>e</sup>	15,000
Senegal, attapulgite	148,700 <sup>r</sup>	121,200 <sup>r</sup>	138,400 <sup>r</sup>	194,900 <sup>r</sup>	195,000
South Africa, attapulgite	7,337	9,229	7,990	14,473	20,419 <sup>4</sup>
Spain:					
Attapulgite	28,307 <sup>r</sup>	24,477 <sup>r</sup>	22,918 <sup>r</sup>	18,975 <sup>r</sup>	19,000
Speiolite	596,324	673,600	733,134	690,395	700,000
United Kingdom <sup>c,5</sup>	140,000	140,000	140,000	140,000	140,000
United States <sup>6</sup>	2,910,000	2,890,000	2,730,000	3,600,000	3,260,000 <sup>4</sup>
Total	4,470,000 <sup>r</sup>	4,600,000 <sup>r</sup>	4,520,000 <sup>r</sup>	5,390,000 <sup>r</sup>	5,060,000

<sup>c</sup>Estimated. <sup>r</sup>Revised.

<sup>1</sup>Excludes centrally planned economy countries and former such countries, some of which presumably produce fuller's earth but for which no information is available. Table includes data available through August 21, 2005.

<sup>2</sup>World totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown.

<sup>3</sup>In addition to the market economy countries listed, France, India, Iran, Japan, and Turkey have reportedly produced fuller's earth in the past and may continue to do so, but output is not reported, and available information is inadequate to make reliable estimates of output levels.

<sup>4</sup>Reported figure.

<sup>5</sup>Salable product.

<sup>6</sup>Sold or used by producers.

TABLE 27  
KAOLIN: WORLD PRODUCTION, BY COUNTRY<sup>1,2</sup>

(Metric tons)

Country <sup>3</sup>	2000	2001	2002	2003	2004 <sup>c</sup>
Algeria	11,616	13,356	9,505	16,591	24,299 <sup>4</sup>
Argentina	34,023	13,584 <sup>r</sup>	13,865 <sup>r</sup>	19,219 <sup>r</sup>	27,883 <sup>4</sup>
Australia, includes ball clay <sup>c</sup>	220,000	220,000	230,000	230,000	230,000
Austria, marketable <sup>c</sup>	50,000	50,000	50,000	50,000	50,000
Bangladesh <sup>c,5</sup>	7,900	8,000	8,100	8,200	8,300
Belgium <sup>c</sup>	300,000	300,000	300,000	300,000	300,000
Bosnia and Herzegovina, crude	-- <sup>r</sup>	13,000 <sup>r</sup>	6,500 <sup>r</sup>	-- <sup>r</sup>	--
Brazil, beneficiated	1,639,673	1,734,359 <sup>r</sup>	1,757,488 <sup>r</sup>	2,081,039 <sup>r</sup>	2,100,000
Bulgaria	150,000 <sup>r</sup>	150,000 <sup>r</sup>	160,000 <sup>r</sup>	170,000 <sup>r</sup>	170,000
Burundi	1,500	--	--	--	--
Chile	6,445	5,300	6,164	11,500 <sup>r</sup>	11,500
Colombia, includes common clay <sup>c</sup>	8,400,000	8,500,000	8,500,000	8,500,000	8,500,000
Czech Republic	5,573,000	5,543,000	3,650,000	4,155,000 <sup>r</sup>	4,000,000
Denmark, sales <sup>c</sup>	2,500	2,500	2,500	2,500	2,500
Ecuador	11,022	703	8,483 <sup>r</sup>	9,330 <sup>r</sup>	9,330
Egypt	290,000	300,000 <sup>c</sup>	300,000	300,000 <sup>c</sup>	300,000
Eritrea	943	588	250	250	100
Ethiopia	1,654	1,800 <sup>c</sup>	3,534 <sup>r</sup>	3,088 <sup>r</sup>	3,100
France, marketable	300,000	300,000 <sup>c</sup>	300,000	300,000 <sup>c</sup>	300,000
Germany	3,637,000 <sup>r</sup>	3,764,000 <sup>r</sup>	3,666,000 <sup>r</sup>	3,467,000 <sup>r</sup>	3,752,000 <sup>4</sup>
Greece	60,000	60,000 <sup>c</sup>	60,000	60,000 <sup>c</sup>	60,000
Guatemala	77 <sup>c</sup>	227 <sup>r</sup>	372 <sup>r</sup>	1,497 <sup>r</sup>	1,500
Hungary, processed <sup>c</sup>	7,100 <sup>r</sup>	8,000 <sup>r</sup>	4,300 <sup>r</sup>	4,500 <sup>r</sup>	5,000
India:					
Processed	160,000	170,000 <sup>c</sup>	170,000	180,000 <sup>c</sup>	180,000
Salable crude	530,000	540,000 <sup>c</sup>	540,000	550,000 <sup>c</sup>	550,000
Indonesia <sup>c</sup>	15,000	15,000	15,000 <sup>4</sup>	15,000	15,000
Iran	850,000	806,000	810,000	800,000 <sup>c</sup>	850,000
Israel <sup>c</sup>	13,000	--	--	--	--
Italy, kaolinitic earth <sup>c</sup>	10,000	10,000	10,000	10,000	10,000
Japan	25,739	19,976	11,756 <sup>r</sup>	12,409 <sup>r</sup>	12,000
Jordan	36,795	38,000 <sup>c</sup>	41,000	179,153 <sup>r</sup>	216,566 <sup>4</sup>
Kazakhstan <sup>c</sup>	70,000	70,000	70,000	70,000	70,000
Kenya	793	700	700	700 <sup>c</sup>	700
Korea, Republic of	2,097,450	2,383,883 <sup>r</sup>	2,831,027	3,102,975 <sup>r</sup>	2,780,019 <sup>4</sup>
Kyrgyzstan <sup>c</sup>	200,000	200,000	237,100 <sup>4</sup>	381,100 <sup>4</sup>	400,000
Madagascar <sup>c</sup>	170	170	110	170	170
Malaysia	233,885	364,458	323,916	376,958	380,000
Mexico	532,268	681,709	745,498	798,407 <sup>r</sup>	800,000
New Zealand	16,300	15,000	16,000	16,000 <sup>c</sup>	16,000
Nigeria	165,765	209,478	200,000 <sup>c</sup>	200,000 <sup>c</sup>	210,000
Pakistan	49,574	50,000 <sup>c</sup>	50,000	50,000 <sup>c</sup>	50,000
Paraguay	6,500	6,500	6,700	6,600 <sup>c</sup>	6,500
Peru	6,165	5,532	1,934	2,653	2,720 <sup>4</sup>
Poland, washed	89,900	101,200	113,500	115,000 <sup>c</sup>	115,000
Portugal <sup>c</sup>	175,000	175,000	175,000	175,000	175,000
Romania	19,007	21,867	22,514	21,274 <sup>r</sup>	21,000
Russia, concentrate	45,000	45,000 <sup>c</sup>	45,000	45,000 <sup>c</sup>	45,000
Serbia and Montenegro:					
Crude	39,475	60,900	60,000	60,000 <sup>c</sup>	60,000
Washed <sup>c</sup>	4,000	10,000	10,000	10,000	10,000
Slovakia	32,000	35,000	33,000	35,000 <sup>c</sup>	35,000
South Africa	98,897	85,556	91,380	85,260	81,901 <sup>4</sup>

See footnotes at end of table.

TABLE 27—Continued  
KAOLIN: WORLD PRODUCTION, BY COUNTRY<sup>1,2</sup>

(Metric tons)

Country <sup>3</sup>	2000	2001	2002	2003	2004 <sup>c</sup>
Spain, marketable, crude and washed <sup>c,6</sup>	365,000 <sup>4</sup>	350,000	350,000	350,000	350,000
Sri Lanka	12,230	9,403	8,613	9,073 <sup>r</sup>	9,200
Thailand, beneficiated	201,226	168,063	127,132	184,562 <sup>r</sup>	185,000
Turkey	595,415	574,550	372,344	370,455 <sup>r</sup>	400,000
Uganda	14	90	178	180 <sup>c</sup>	200
Ukraine <sup>c</sup>	225,000	225,000	225,000 <sup>4</sup>	225,000	225,000
United Kingdom, sales <sup>7</sup>	2,420,000	2,400,000 <sup>c</sup>	2,400,000	2,400,000 <sup>c</sup>	2,400,000
United States <sup>8</sup>	8,800,000	8,110,000	8,010,000	7,680,000	7,760,000 <sup>4</sup>
Uzbekistan <sup>c</sup>	5,300,000	5,500,000	5,500,000	5,500,000	5,500,000
Venezuela <sup>c</sup>	10,000 <sup>4</sup>	10,000	10,000	10,000	10,000
Vietnam <sup>c</sup>	520,000	600,000	600,000	650,000	650,000
Total	44,700,000 <sup>r</sup>	45,100,000 <sup>r</sup>	43,300,000 <sup>r</sup>	44,400,000 <sup>r</sup>	44,400,000

<sup>c</sup>Estimated. <sup>r</sup>Revised. -- Zero.

<sup>1</sup>World totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown.

<sup>2</sup>Table includes data available through August 21, 2005.

<sup>3</sup>In addition to the countries listed, China, Morocco, and Suriname may also have produced kaolin, but information is inadequate to make reliable estimates of output levels.

<sup>4</sup>Reported figure.

<sup>5</sup>Data for year ending June 30 of that stated.

<sup>6</sup>Includes crude and washed kaolin and refractory clays not further described.

<sup>7</sup>Dry weight.

<sup>8</sup>Kaolin sold or used by producers.